



WHAT IS CLAIMED IS:

- 1. A cathode material for a rechargeable electrochemical cell, said cell also comprising an anode and an electrolyte, the cathode comprising a compound having the formula LiMPO₄, where M is at least one first-row transition-metal cation.
- 2. The cathode material of claim 1, where M is further defined as being selected from the group consisting of Mn, Fe, Co, and Ni.
- 3. The cathode material of claim 1, where M is further defined as being a combination of cations, at least one of which is selected from the group consisting of Mn, Fe, Co and Ni.
 - 4. The cathode material of claim 3, where M is $Fe_{1-x}Mn_x$ or $Fe_{1-x}Ti_x$ and 0 < x < 1.
 - 5. The cathode material of claim 2, wherein the cathode material has the formula LiFePO₄.
 - 6. A cathode material for a rechargeable electrochemical cell, said cell also comprising an anode and an electrolyte, the cathode material comprising a rhombohedral NASICON material having the formula $Y_xM_2(PO_4)_3$, where M is at least one first-row transition-metal cation and $0 \le x \le 5$ and Y is Li or Na.

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- 7. The cathode material of claim 5, where M s selected from the group consisting of Fe, V, Mn, and Ti.
- 8. The cathode material of claim 7, wherein the cathode material has the formula $\text{Li}_{3+x}\text{Fe}_2(\text{PO}_4)_3$, where $0 \le x \le 2$.
 - 9 The cathode material of claim 7, wherein the cathode material has the formula Li₃Fe₂(PO₄)₃.

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- 10. The cathode material of claim 7, having the formula $\text{Li}_{1+x}\text{Ti}_2(\text{PO}_4)_3$.
- 11. The cathode material of claim 7, having the formula Li₂FeTi(PO₄)₃.

The cathode material of claim 7, having the formula $\text{Li}_x\text{TiNb}(\text{PO}_4)_3$, where $0 \le x \le 2$.

- 13. The cathode material of claim 7, having the formula $\text{Li}_{1+x}\text{FeNb}(\text{PO}_4)_3$, where $0 \le x \le 2$.
- 14. The cathode material of claim 7, prepared by the process comprising the steps:
 - (a) preparing $Na_2Fe_2(PO_4)_3$; and
 - (b) contacting said Na₂Fe₂(PO₄)₃ with a molten lithium salt, such that an ionic exchange reaction occurs.
- 15. The cathode material of claim 7, prepared by a direct solid state reaction.
- 16. A cathode material for a rechargeable electrochemical cell, said cell also comprising an anode and an electrolyte, the cathode material comprising a rhombohedral NASICON material having the formula $Y_xM_2(PO_4)_y(XO_4)_{3-y}$, where $0 < y \le 3$, M is a transition-metal atom, $0 \le x \le 5$, Y is Li or Na, and X = Si, As, or S.
- 17. The cathode material of claim 16, wherein the cathode material has the formula $\text{Li}_{1+x}\text{Fe}_2(\text{SO}_4)_2(\text{PO}_4)$, where $0 \le x \le 2$.
- 18. The cathode material of claim 17, prepared by the process comprising the steps:
 - (a) preparing an aqueous solution comprising FeCl₃, (NH₄)₂SO₄, and LiH, PO₄:
 - (b) evaporating the solution to obtain dry material; and

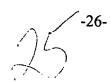
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- (c) heating the dry material to about 500°C.
- 19. A cathode material for a rechargeable electrochemical cell also comprising an anode and an electrolyte, the cathode comprising a rhombohedral NASICON material having the formula $A_{3-x}V_2(PO_4)_3$, where A may be Li, Na or a combination thereof and $0 \le x \le 2$.
- 20. The cathode material of claim 19, wherein the cathode material has the formula $\text{Li}_{2-x}\text{NaV}_2(\text{PO}_4)_3$, where $0 \le x \le 2$.
- 10 21. The cathode material of claim 19, prepared by the process comprising the steps:
 - (a) preparing Na₃V₂(PO₄)₃; and
 - (b) contacting said Na₃V₂(PO₄)₃ with a molten lithium salt, such that an ionic exchange reaction occurs.
- 22. The cathode material of claim 19, prepared by a direct solid-state reaction.
 - 23. A secondary battery comprising an anode, a cathode and an electrolyte, said cathode comprising an ordered olivine compound having the formula LiMPO₄, where M is at least one first-row transition-metal cation.
 - 24. The battery of claim 23, where M is further defined as being selected from the group consisting of Mn, Fe, Co, and Ni.
- 25. The battery of claim 23, where M is further defined as being a combination of cations, at least one of said cations being selected from the group consisting of Mn, Fe, Co, and Ni.

26. The battery of claim 25, wherein M is $Fe_{1-x}Mn_x$ or $Fe_{1-x}Ti_x$, where $0 \le x \le 1$.





- 27. A secondary battery comprising an anode, a cathode and an electrolyte, said cathode comprising a rhombohedral NASICON material having the formula $Y_xM_2(PO_4)_3$, where M is at least one first-row transition-metal cation and $0 \le x \le 5$ and Y is Li or Na, other than $\text{Li}_{2+x}\text{FeTi}(PQ_4)_3$.
- 28. The battery of claim 27, where M is selected from the group consisting of Fe, V, Mn, and Ti.
- 29. The battery of claim 28, wherein the cathode material has the formula $\text{Li}_{3+x}\text{Fe}_2(\text{PO}_4)_3$, where $0 \le x \le 2$.
 - 30. The battery of claim 29, wherein the cathode material has the formula Li₃Fe₂(PO₄)₃.
 - 31. The battery of claim 28, wherein the cathode material has the formula Li₂FeTi(PO₄)₃.

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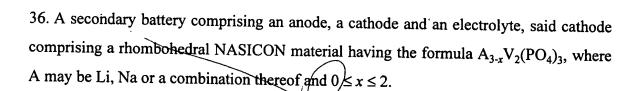
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32. The battery of claim 28, wherein the cathode material has the formula $\text{Li}_x\text{TiNb}(\text{PO}_4)_3$, where $0 \le x \le 2$.

- 33. The battery of claim 28, wherein the cathode material has the formula $\text{Li}_{1+x}\text{FeNb}(\text{PO}_4)_3$, $0 \le x \le 2$.
 - 34. A secondary battery comprising an anode, a cathode and an electrolyte, said cathode comprising a rhombohedral NASICON material having the formula $Y_xM_2(PO_4)_y(XO_4)_{3-y}$, where $0 < y \le 3$, M is a transition-metal atom, $0 \le x \le 5$, Y is Li or Na, and X = Si, As, or S.
- 35. The battery of claim 34, wherein said cathode material has the formula $\text{Li}_{1+x}\text{Fe}_2(\text{PO}_4)(\text{SO}_4)_2$, where $0 \le x \le 2$.



37. The battery of claim 36, wherein the cathode material has the formula $\text{Li}_{2+x}\text{NaV}_2(\text{PO}_4)_3$, where $0 \le x \le 2$.

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